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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/801,499	03/15/2004	Daniel Calafut	018865-015200US	1835

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EXAMINER

MAI, ANH D

ART UNIT

PAPER NUMBER

2814

DATE MAILED: 10/20/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/801,499

Applicant(s)

CALAFUT ET AL.

Examiner

Anh D. Mai

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 29 September 2005.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-11 is/are pending in the application.
- 4a) Of the above claim(s) 11 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-10 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 15 March 2004 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date <u>8/16/04</u> . | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Election/Restrictions

1. Applicant's election without traverse of claims 1-10 in the reply filed on September 29, 2005 is acknowledged.

Claim Objections

2. Claim 1 is objected to because of the following informalities: there are two periods(.) in claim 1, line 15 (adjacent trenches.) and line 17 (active area.). Appropriate correction is required.

Drawings

3. The drawings are objected to under 37 CFR 1.83(a). The drawings must show every feature of the invention specified in the claims. Therefore, the "first trench has a thicker insulating layer along its bottom than along its sidewalls" (claim 9) and "each of the pair of adjacent trenches and the first trench has a thicker insulating layer along its bottom than along its sidewalls" (claim 10) must be shown or the feature(s) canceled from the claim(s). No new matter should be entered.

Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. The figure or figure number of an amended drawing should not be labeled as "amended." If a drawing figure is to be canceled, the appropriate figure must be removed from the replacement sheet, and where necessary, the remaining figures must be renumbered and appropriate changes made to the brief description of the several views of the drawings for consistency.

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Additional replacement sheets may be necessary to show the renumbering of the remaining figures. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 1-8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sapp (U.S. Patent No. 6,351,018) of record.

With respect to claim 1, Sapp teaches a monolithically integrated structure combining a field effect transistor and a Schottky structure (210) in an active area of a semiconductor substrate substantially as claimed, wherein:

the field effect transistor comprises:

a first trench (200) extending into the substrate (202) and substantially filled by conductive material (206) forming a gate electrode of the field effect transistor; and

a pair of doped source regions (212) positioned adjacent to and on opposite sides of the trench (200) and inside a doped body region (214), the doped source regions (212)

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forming a source electrode of the field effect transistor, and the substrate (202) forming a drain electrode of the field effect transistor, and

the Schottky structure (210) comprises:

a pair of adjacent trenches (220-3; 200-4) extending into the substrate (202), the pair of adjacent trenches (200-3; 200-4) being substantially filled by conductive material (206) which is separated from trench side-walls by a thin layer of dielectric (204); and

a Schottky diode having a barrier layer (218) formed on the surface of the substrate (202) and between the pair of adjacent trenches (200);

wherein the Schottky structure consumes a minimal portion of the active area, and the field effect transistor consumes the remaining portion of the active area. (See Figs. 2-7).

Thus, Sapp is shown to teach all the features of the claim with the exception of explicitly disclosing the portion occupied by the Schottky structure. Note that the claimed portion 2.5% to 5.0% of active area do not appear to be critical.

However Sapp also teaches: [S]ince the area of the Schottky diode determines its forward voltage drop in response to current, Schottky structures with different numbers of adjacent trenches can be devised to arrive at the desired area. (See col. 5, lines 3-6).

Note that the specification contains no disclosure of either the *critical nature of the claimed Schottky structure consumes 2.5% to 5.0% of active area* or of any unexpected results arising therefrom. Where patentability is aid to based upon particular chosen dimension or upon another variable recited in a claim, the Applicant must show that the chosen dimension are critical. *In re Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

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Therefore, it would have been obvious to one having ordinary skill in the art at the time of invention to form the monolithically integrated structure of Sapp having a portion of active area consumed by the Schottky structure to enhance the performance characteristic of the MOSFET switch.

Further, within purview of one having ordinary skill in the art and as taught by Sapp, it would have been obvious to determine the optimum area consumed by the Schottky structure. See *In re Aller, Lacey and Hall* (10 USPQ 233-237) "It is not inventive to discover optimum or workable ranges by routine experimentation.

With respect to claim 2, the field effect transistor of Sapp further comprises a metal layer (216) contacting the pair of doped source regions (212), the metal layer (216) and the barrier layer (218) comprise one of either titanium tungsten or titanium nitride.

With respect to claim 3, the barrier layer (218) and the metal layer (216) of Sapp contacting the source regions (212) connect together by an overlying layer of metal. (See Fig. 2).

With respect to claim 4, the barrier layer (218) of Sapp forms the Schottky diode anode terminal and the substrate (202) forms the Schottky diode cathode terminal.

With respect to claim 5, the integrated structure of Sapp further comprises a second trench (200) adjacent to the first trench (200), the second trench forming the gate electrode of the field effect transistor in a similar fashion to the first trench, wherein a distance between the first trench (200) and the second trench (200) is greater than a distance W separating the pair of adjacent trenches (200-3; 200-4), and wherein the

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barrier layer (218) and a metal layer (216) contacting the source regions of the field effect transistor comprise one of either titanium tungsten or titanium nitride.

With respect to claim 6, the conductive material in the first and second trenches of Sapp electrically connects to the conductive material in the pair of adjacent trenches the Schottky diode is formed.

With respect to claim 7, the conductive material of Sapp in the pair of adjacent trenches between which the Schottky diode is formed is electrically isolated from the conductive material in the first and second trenches.

With respect to claim 8, the conductive material (206) of Sapp in the pair of adjacent trenches between which the Schottky diode is formed, is recessed into the pair of adjacent trenches and covered by a layer of dielectric material. (See Fig. 4).

5. Claims 9 and 10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sapp '018 as applied to claim 1 above, and further in view of Hurst et al. (U.S. Patent No. 6,437,386).

Sapp teaches a monolithically integrated structure as described in claim 1 above including a first trench extending into the substrate, wherein an insulating layer (204) formed lining the side and bottom of the first trench.

Thus, Sapp is shown to teach all the features of the claim with the exception of the thickness of the insulating layer of the first trench as well as the pair of adjacent trenches along the bottom is thicker than that along the sidewalls.

However, Hurst teaches dielectric layer formed along the bottom (27) of a trench is thicker than that formed along the sidewalls (21) substantially reduces gate charge to

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reduce gate-to-drain capacitance thereby increasing the efficiency and prolong the life of the semiconductor device.

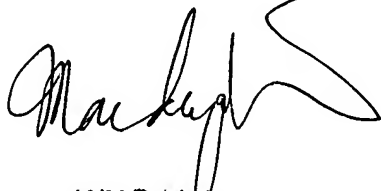
Therefore, it would have been obvious to one having ordinary skill in the art at the time of invention to form the insulating layer lining the trenches of Sapp thicker on the bottom than on the sidewalls as taught by Hurst to reduce gate-to-drain capacitance thereby increasing the efficiency and prolong the life of the semiconductor device.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Anh D. Mai whose telephone number is (571) 272-1710. The examiner can normally be reached on 8:00AM-5:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael Fahmy can be reached on (571) 272-1705. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



ANH D. MAI
PRIMARY EXAMINER